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Exploration of Reforming Hydraulics Experimental Teaching Methods Based on Engineering Education Accreditation

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Abstract

The implementation of relevant quality assurance systems in engineering education related to engineering education accreditation is fundamental to cultivating high-quality, highly capable, and innovative engineering talents in universities. This paper conducts comprehensive reforms through the analysis of engineering education accreditation standards, exploration of new experimental teaching methods, and the construction of a multi-platform practical teaching system. It aims to establish a practical teaching and training system under the professional engineering education accreditation framework, creating experimental teaching components that align with the standards of engineering education accreditation. The goal is to nurture individuals with solid theoretical foundations, strong practical skills, high comprehensive qualities, and a spirit of innovation and capability, who can serve as application-oriented senior engineering and technical professionals as well as managers. By investigating the hydrodynamics laboratory experiments offered by related institutions and combining this with the realities of our university, the study explores reforms in the teaching methods for hydrodynamics laboratory experiments suitable for our undergraduate students specializing in water resources.

Keywords

Engineering Education Accreditation; Hydrodynamics Experiment; Teaching Reform.

1. Introduction

As a key component in establishing a quality monitoring system for engineering education, professional engineering education accreditation holds significant importance in advancing engineering education reforms [1], further enhancing the quality of engineering education, facilitating international mutual recognition of China's engineering education, and boosting international competitiveness [2]. The primary focus of engineering education accreditation is to cultivate the practical and innovative abilities of contemporary university students [3]. In terms of the current educational environment, the cultivation of practical and innovative abilities is mainly reflected in: through the innovation of experimental teaching methods, enabling students to possess strong innovative awareness and hands-on skills.

In terms of cultivating students' innovative awareness and abilities, the utility of engineering practice teaching is significantly greater than that of theoretical teaching. For the course of hydraulics, the importance of the status of hydraulics experiment teaching is evident [4]. As an extremely important professional foundation experimental course for students in water conservancy, hydraulics experiments play an irreplaceable role in helping students understand and grasp abstract concepts, complex flow phenomena, and dry theoretical derivations in hydraulics.

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Currently, the teaching system of hydraulics experiment courses can ensure that students meet the basic requirements of experimental teaching, such as understanding experiment categories and experimental knowledge points, but it cannot meet the reform requirements of experimental methods emphasized by engineering education accreditation, which are "formulating research technical routes, designing experimental schemes" and "expanding experimental content based on experimental results" [5]. Therefore, how universities can respond to the "practical innovation" indicator in professional engineering education accreditation and ultimately improve the cultivation of students' innovative abilities through "continuous improvement" is an urgent problem that needs to be solved in the practical education of all engineering colleges.

2. Problems in the Teaching of Hydraulics Experiment Courses

Currently, there are the following issues in the hydraulics experiment course at our school:

(1) Limitations of Experimental Resources and Insufficient Funding

Limitations in experimental resources and insufficient construction funds greatly restrict the establishment of innovative hydraulics experiment projects for water-related engineering majors. Furthermore, even for conventional hydraulics experiment projects, due to heavy teaching tasks in laboratories, tight laboratory resources, and difficulties in conducting work for non-enrolled students, they are being gradually reduced in more and more engineering majors.

(2) Limitations of Traditional Teaching Models

Hydraulic experiments belong to the foundational experiments in water-related majors. Due to limitations in conditions such as venue and resources, students typically can only imitate the operations of the experimental instructor or follow the steps outlined in the experimental manual when conducting experiments in the field. Based on the author's extensive experience in experimental instruction, while most students are able to complete the final experiment report well, when questioned in class or after class, it is evident that they have merely "completed" the experiment without truly understanding the key knowledge points of each experiment, let alone expanding and innovating on the experimental projects. This results in a loss of the "innovation ability" cultivation required by engineering education accreditation.

(3) Inadequate Laboratory Management System

Although the school has advocated for the implementation of 'open experiments' for many years, the actual time that the laboratory is truly 'open' is limited to the teaching hours of the experimental courses due to constraints such as personnel allocation and funding. For students who want to additionally expand and innovate upon basic experimental projects or have an interest in learning about hydraulics-related experiments but are not majors in the field, they can only seek temporary assistance from laboratory administrators on campus, but this is not a long-term solution.

(4) Obstacles in Interdisciplinary Integration

The integration and blending of specialized knowledge across different majors have not been fully achieved. In the current context of emphasizing interdisciplinary communication and cross-disciplinary integration, students from other departments and majors are unable to access hydraulics experiment projects through effective channels, hindering the promotion of hydraulics experiments and severing the cross-disciplinary integration between water conservancy engineering and disciplines such as electrical engineering, information and communication engineering, and software engineering.

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3. Reform Objectives of Hydraulics Experiment Teaching Methods Based on Engineering Education Accreditation

(1) The Teaching Objective of Enhancing Students' Innovative Abilities

This project aims to establish a practical teaching and training system that aligns with engineering professional certification, promotes continuous improvement of the practical curriculum system for water conservancy and hydropower engineering, and enhances students' innovation ability.

(2) Constructing an Innovative Hydraulic Experiment Platform to Facilitate Teaching Reform

This project relies on the Hydraulics Innovation Laboratory to create a platform for fostering hydraulic innovation projects, making the practical outcomes and reform models available for reference in the teaching reform of other engineering experiment courses.

4. Research Content of Teaching Reform in Hydraulic Experiment Courses

(1) Research Subject

This research will first be implemented in the water conservancy and hydropower engineering major of the school of hydraulic engineering at Nanchang Institute of Technology, specifically in the classes of 2020 (1), 2021 (1), and 2022 (1). It will then be promoted to all students in this major, serving as a reference for local colleges and universities across the province and even the country.

(2) Research Methods

1) For different classes in the same grade, implement new and old practical teaching content, teaching methods, assessment methods, and grading standards separately, to explore the intrinsic motivation for the reform of practical teaching, enabling the course instruction to achieve teaching objectives and meet graduation requirements.

2) Establish a quality supervision system that facilitates the implementation of the practical teaching system and encourages continuous improvement.

3) Establish an effective multi-platform experimental teaching system to cultivate top innovative talents in hydraulic engineering through practice.

(3) Research Content

1) Reasonably increase or decrease hydraulic experiment projects

The purpose of the hydraulic experiment course is to enable students to intuitively observe the phenomena of water flow movement, to master the three fundamental equations of hydraulics, to learn the basic measurement methods of hydraulic parameters, and to train students in organizing experimental data and writing experimental reports. It plays an important role in enhancing students' ability to connect theory with practice, cultivating their practical skills and research capabilities, improving their independent thinking, comprehensive analysis skills, and hands-on abilities, as well as in learning the course of hydraulics. The author conducted research on the implementation of hydraulic experiment projects at relevant hydraulic engineering institutions such as Hohai University, Xi'an University of Technology, and Lanzhou University of Technology, examining the degree of 'innovation' in hydraulic experiments across different universities. In conjunction with the specific circumstances of Nanchang Engineering College, purposefully and strategically establish innovative experimental projects suitable for this institution. In the process of reform practice, the proportion of verification and basic experimental projects has been reduced, while the proportion of comprehensive, design, and innovative experimental projects has been increased. After the reform, only the hydrostatics experiment project remains for verification experiments, while five innovative experimental projects have been added, including the water surface curve experiment, weir flow experiment,

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hydraulic jump experiment, energy dissipation pool experiment, and energy dissipation sill experiment.

2) Implementation of Hydraulics Experimental Teaching Methods Based on Continuous Improvement

Based on the continuous improvement requirements of engineering education accreditation, we will promote a comprehensive revision of the professional training program and the experimental course syllabus, re-establish the positioning of experimental teaching, and strive to shift towards a practical teaching model that cultivates students' independent innovation abilities. We will explore teaching methods that are suitable for the characteristics of different colleges and majors within our university: systematically integrating the key and difficult knowledge points of hydraulics experiments in a vertical manner, while striving for the mutual penetration of various horizontal experimental knowledge points. Consolidate important knowledge points from theoretical teaching through experimental instruction. For the teaching faculty, it is essential to focus on the common development of students' learning in the laboratory. Since each student has a different level of understanding of the knowledge points, this requires attention to the individual development of students during the processes of experimental operation, recording, calculation, and summarization, highlighting the role of students as active participants. The innovative experimental teaching method explored in this article aims to maximize the potential of students' knowledge, which is beneficial for cultivating students' creative thinking and developing their innovative abilities.

3) The investment in a new online virtual simulation experiment platform

Due to the high requirements for equipment, facilities, and funding in hydraulic engineering experimental projects, most universities find it difficult to invest in experiments that meet their own needs. The development of virtual simulation experimental platforms has greatly reduced related consumption. In comprehensive experimental projects, if conditions permit, students can use the measurement results from virtual simulation experiments to verify practical results according to experimental requirements, and ultimately validate them against theoretical results from textbooks; if conditions do not permit, students can directly use the measurement results from virtual simulation experiments to validate against theoretical results. Virtual simulation experiments, free from temporal and spatial constraints, not only enable students in water-related majors to extend their thinking and innovate in experimental design but also offer all other students interested in hydraulic experiments the opportunity to repeatedly design and practice experimental content during their spare time. This process helps uncover patterns and significantly enhances their ability to apply knowledge and solve problems independently.

At the same time, in order to ensure the achievement of the training objectives and graduation requirements of this major, it is essential to guarantee that the evaluation results from all parties regarding the training objectives, graduation requirements, curriculum system, and course quality are used for continuous improvement, and that the effects of the improvements are promptly and accurately fed back, thereby comprehensively enhancing the quality of talent cultivation in this major. Students participate in personalized innovative experimental or research project training, focusing on cultivating students' ability for technological innovation, while achieving breakthroughs in specific areas while strengthening overall development. Therefore, an innovation experimental area has been established in our school's hydraulics laboratory, specifically for conducting innovative experiments in hydraulics as well as competitions such as the Challenge Cup and innovation and entrepreneurship training projects. In addition, cross-combinations can be made between experimental projects at different levels, thereby achieving the true goal of 'diversified' engineering experimental teaching.

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5. Implementation Plan for the Reform of Hydraulics Experiment Teaching Based on Engineering Education Accreditation

This research implementation period spanned three years, from 2021 to 2023, and was divided into six stages.

(1) First Stage: In alignment with the current hydraulics experiment teaching syllabus and the requirements of engineering education accreditation, as well as university guidelines, reforms was implemented in both the experimental content and teaching methods. These changes culminated in a new, actionable hydraulics experiment teaching syllabus and accompanying experiment guide, which was utilized for the the class of 2020 (1) of the water conservancy and hydropower engineering major.

(2) Second Stage: Based on the teaching reform effects of the class of 2020 (1), a comparative analysis was conducted with other classes that had not implemented the reforms, leading to improvements and enhancements of the hydraulics experiment teaching syllabus and experiment guide.

(3) Third Stage: The improved hydraulics experiment teaching syllabus and accompanying experiment guide were implemented for the class of 2021 (1) in the water conservancy and hydropower engineering major.

(4) Fourth Stage: Based on the effects of the reforms in the third phase, continuous improvements were made through comparative analysis with other classes of 2021 that had not implemented the reforms

(5) Fifth Stage: The improved hydraulics experiment teaching syllabus, experiment guide, and multi-platform practical teaching system were applied to class of 2022 (1) in the Water Conservancy and Hydropower Engineering major.

(6) Sixth Stage: Based on the effects of the reforms in the fifth phase, a comprehensive experimental teaching reform plan was summarized through comparative analysis with other classes that had not implemented the reforms.

6. Conclusions

In summary, hydraulics experiments are an essential component of the hydrology curriculum, serving as a vital link between foundational and specialized courses. This paper mainly conducts in-depth innovation and reform for the hydraulics experiment teaching methods in engineering colleges from the following three aspects:

(1) Enhancing Comprehensive Quality and Improving Application Skills

This article breaks the traditional verification experiment teaching model that focuses on service teaching and gradually increases the proportion of innovative experiments. Starting from the premise that 'creative thinking based on practice begins with problems,' it encourages students to participate in various science and technology competitions and college student innovation fund projects during the experimental process. It trains students' basic design skills and engineering technology application abilities to achieve the goal of applying what they have learned.

(2) Constructing a New Teaching System to Foster Practical and Innovative Skills

The research focuses on continuous improvement and explores new teaching methods suitable for the hydraulics experiments of the Water Conservancy and Hydropower Engineering program at our university. By adding a new online virtual simulation experiment platform, it aims to cultivate students' practical and innovative abilities, thereby laying a solid foundation for the emergence of innovative projects.

(3) Promoting Practical Achievements and Providing References for Teaching Reform

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The research focuses on the practical outcomes of the reform in hydraulics experiment teaching for the Water Conservancy and Hydropower Engineering program, which can first be promoted and applied in other water-related majors at our university, and then gradually extended to other engineering disciplines. The teaching reform ideas presented in this article can serve as a reference for the teaching reform of other engineering practice courses.

Based on the relevant findings from this outcome of teaching reform, the next steps can be pursued in the following three areas: (1) Further develop innovative experimental projects in hydraulics, while utilizing the funding for laboratory construction provided by the school to purchase instruments and improve existing experimental conditions, striving to develop more innovative experimental projects;(2) Currently, the teaching syllabus for hydraulics experiments in various majors does not include virtual simulation experiment projects. After exploring this project, suitable innovative experimental projects in hydraulics can be selected for each major, continuously cultivating students' innovative and practical abilities; (3) In the next phase, the teachers and students of the hydraulics research group will discuss how to utilize online simulation platforms to design relevant innovative experimental projects, participate in national water conservancy innovation competitions and the Challenge Cup competition, and further enhance the innovation and practical abilities of our school's water conservancy students.

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